are to consider "Part I", itself consists of a "Part I" and a "Part II", so that some such citation "Thaxter, Monog. Laboulbeniaceae, Part II, pp. 251–396" might possibly be interpreted as referring to the contribution of twelve years ago as well as to that of the present year. But, of course, no one ought to quote the work in any such fashion. If the Memoirs of the American Academy of Arts and Sciences are cited, as they should be, any such trifling chance of ambiguity will be obviated.

That such a notable extension of human knowledge as is evidenced in Professor Thaxter's monograph has been the work of an American scholar, must always remain a source of pride to American botanists. In connection with a contribution of this kind, it occurs to the reviewer to remark that the fungi parasitic on marine algae are still practically unknown and that though they are probably much less numerous than those parasitic on insects, they offer a field that is well worthy of the attention of mycologists.

Marshall A. Howe

PROCEEDINGS OF THE CLUB

November 25, 1908

The meeting was called to order at the Museum Building of the New York Botanical Garden at 3:40 p. m., with Dr. M. A. Howe in the chair. There were 14 persons present. The minutes of the meeting of November 10 were read and approved.

The resignation of Dr. Valery Havard, dated November 8, 1908, was read. A motion was made and carried that the resignation of Dr. Havard be accepted and that his name be transferred to the list of corresponding members.

There was no announced scientific program for this meeting, but the following communications were made:

Dr. Britton showed fruits of the rare and local tree, *Prioria copaifera* Griseb., which he collected in company with Mr. William Harris, at Bachelor's Hall, Jamaica, near where it was originally discovered sixty years ago by Nathaniel Wilson who sent it to Grisebach. *Prioria* is one of the largest trees of Jamaica, sometimes attaining a height of ninety feet, and is a member of the senna family. So far as is known, this tree is found only on two estates in Jamaica, and grows at an elevation of from five to six hundred feet. This species is characterized by having a one-seeded legume, which is indehiscent. The genus *Prioria* is reported to be represented also in the Republic of Panama.

Dr. Murrill displayed photographs and colored drawings of several of the larger local fungi. He also explained reproduction of colored drawings by the four-color process. This process seems to be the most satisfactory for representing fungi in colors.

Mr. Nash exhibited a living plant of *Dendrobium Coelogyne*, a rare orchid from Burma, which has just flowered in the conservatories of the New York Botanical Garden. Specimens of *Coelogyne* and of other species of *Dendrobium* were also shown to illustrate the characters of these two genera. While the flowers of *Dendrobium Coelogyne* resemble those of a *Dendrobium*, the habit is that of a *Coelogyne*.

The Club adjourned at 4:30 P. M.

PERCY WILSON,
Secretary

DECEMBER 8, 1908

The meeting was held at the American Museum of Natural History, President Rusby in the chair. About seventy-five persons were present. After the reading of the minutes of the preceding meeting, the following persons were elected to membership: Miss Jane R. Condit, 1230 Amsterdam Ave., New York City; Mrs. H. Mark Thomas, 239 West 103d St., New York City, and Professor Guy West Wilson, Upper Iowa University, Fayette, Iowa. The announced scientific paper of the evening on "Mechanical Response of Plants" was then presented by Sir Jagadis Chunder Bose, professor in the Presidency College of Calcutta and author of "Response in the Living and Non-Living", "Plant Response as a Means of Physiological Investigation", etc. The presentation of the subject was accompanied by an exhibition of some of the ingenious and delicately contrived apparatus constructed by Professor Bose for the purpose of measuring and recording the responses of plants to various stimuli. Following is an abstract of the paper compiled from notes furnished by Professor Bose :

The effect of stimulus impinging on a responding tissue is to induce a fundamental molecular derangement. This condition of derangement constitutes excitation. On the cessation of stimulus, there is a slow recovery, the tissue returning to its original condition. This molecular reaction is itself beyond our scrutiny, but it may be shown that we can gauge its intensity and extent by the observation and record of certain concomitant changes induced by it in the responding tissue. Amongst these are (1) changes of form, manifested as mechanical response, and (2) changes of electrical condition, which may be recorded as electrical response.

The intensity of the responsive change will obviously depend on the two factors of strength of stimulus and physiological condition of the tissue. Hence, when stimulus is constant, the amplitude of response gives us a measure of the physiological condition. Now we know that the changing environment must induce unknown changes in this physiological condition, of which there is no outward sign. But we are here enabled to make the plant itself reveal its condition, by the reply it makes to the blow of a stimulus. A stimulating agent will exalt, and a depressing agent diminish or abolish, this response. We have thus a means of attacking the deeper problem of the physiological variation in an organism.

The speaker had been able to overcome the numerous difficulties which occur in connection with the automatic recording of the mechanical response of the plant, by devising three types of instrument. These are (1) the oscillating recorder, (2) the optical lever, and (3) the balanced crescograph.

In the oscillating recorder, the recording lever is made of light aluminum wire and is suspended vertically on jewelled bearings. This lever is L-shaped, and the shorter arm, at right angles to the longer, is attached to the responding leaf. The great advantage conferred by the oscillating recorder lies in the fact that the friction of the writing point against the recording surface is practically eliminated. The source of friction in such arrangements arises from permanence of this contact. In this instrument, however, the writing lever is virtually free, except for the brief intervals in which the smoked glass surface is brought into periodic contact with it. For these records, the glass surface moves in a vertical plane by means of clockwork, and a minute oscillation to and fro is given to it by the agency of an electro-magnetic arrangement. The period of this oscillation is, say, one fifth of a second, and the record is thus made to consist of a series of dots, separated by time-intervals of one fifth of a second. Thus we can see the time-relations of the curve at a glance.

For responsive movements of minute leaflets the speaker employed the optical lever. By use of this a very high magnification is possible. The record is made on a traveling photographic plate by the spot of light reflected from the optical lever, connected with the responding plant.

For the instant detection of the effect of stimulus on the rate of growth, the balanced crescograph is used. Here a balanced and stationary point of light undergoes a sudden movement up or down, according as the rate of growth is enhanced or depressed by the action of an external agent.

In order to study the effects of external agencies on physiological excitability, it is first necessary to obtain a series of normal responses under stimuli of uniform intensity and duration, applied at regular predetermined intervals. This is accomplished by means of the automatic stimulator, in which an expansible fan periodically closes the exciting circuit. The intervals between successive applications and the period of stimulation are, in this instrument, capable of adjustment at will.

In a complete curve of response of the sensitive leaf or leaflet of *Mimosa* or *Biophytum sensitivum*, we find (1) a short horizontal line representing the latent period, (2) an up-curve showing attainment of maximum reaction ; followed by (3) a down-curve representing the recovery. The latent period in a vigorous *Mimosa* is about .24 of a second. The effect of fall of temperature or fatigue results in the prolongation of this latent period to .3 of a second in the former, and .58 in the latter case. The maximum fall of the leaf is attained in 1.5 seconds. Complete recovery takes place in 6 minutes in summer, and in 18 minutes in winter. In a leaflet of *Biophytum* the maximum fall is attained in .5 of a second and full recovery is reached in 3 minutes. The excitatory fall of the leaf takes place when stimulus is applied at or near the responding point. Seen from different points of view, this reaction will appear as a diminution of turgor in the pulvinus, constituting a negative turgidity-variation ; or a shortening or contraction of the more excitable lower half of the pulvinus. Electrically speaking, this reaction will have its concomitant in an electrical variation of galvanometric negativity. It is convenient to include all these excitatory symptoms together, under the single term *negative response.* Here, however, we may describe a responsive change of precisely opposite character, which takes place under definite conditions. This *positive response* consists of an erectile movement of the leaf, a positive turgidity-variation, expansion, and an electrical change of galvanometric positivity. The occurrence of this positive response may be demonstrated, in *Mimosa,* by applying stimulus at a point distant from the responding organ. In a certain experiment this positive or erectile response occurred .6 of a second after the application of the stimulus, and was followed, 2.8 seconds later, by the normal excitatory fall of the leaf. Here we have a response which is *diphasic,* positive followed by negative. When stimulus is moderate, and applied at a still greater distance, the response evoked is positive alone. These facts obtain universally, and from them we derive the following law of direct and indirect stimulation :

The effect at the responding-region of a strong stimulus transmitted to a short distance, or through a good conducting channel, is negative. The effect transmitted to a great distance, or through a semi-conducting channel, is positive.

Responsive movements, like those of the "sensitive" plants so-called, can be detected also in ordinary plants. It will be noticed, in *Mimosa,* that the responsive movement is made possible by the unequal excitability of the upper and lower halves of the pulvinus, the movement being determined by the greater shortening or contraction of the lower. If now we take a hollow tubular organ of some ordinary plant, say the peduncle of daffodil, it is clear that the protected inner side of the tube must be the more excitable. When this is cut into the form of a spiral strip, and excited by means of an electrical shock, we observe a responsive movement to take place by *curling*, due to the greater contraction of the inside of the strip. This mechanical response is at its maximum at that season which is optimum for the plant. When the plant is killed, its response disappears.

In *Mimosa*, under continuous stimulation, there is a fatigue-reversal, the responsive fall being converted into a movement of erection. The same thing happens in the response of ordinary plants, when the first contractile movement of the spiral, for instance, is reversed, under continuous stimulation, to an expansive uncurling.

An important series of observations is that on the modification of response by the tonic condition of the tissue. When the condition is sub-tonic, response is by the abnormal positive, instead of the normal negative, reaction. A strong or long-continued application of stimulus, however, converts this abnormal positive into normal negative.

Another important phenomenon is that for which the name of *multiple response* has been suggested. When the stimulus is very strong, the response is often not single, but repeated, or multiple. Excess of stimulus is thus seen to remain latent in the tissue, for rhythmic expression later. This storage of energy from the environment may in some cases be so great as to cause the continuance of rhythmic activity, even in the absence of immediate stimulation. We thus obtain a natural transition into so-called spontaneous or autonomous movements.

The various peculiarities of the spontaneous movements exhibited by *Desmodium gyrans*, or the telegraph plant, may be studied in the automatic record taken by the optical lever. The rhythmic tissues of the plant are then found to have characteristics which correspond to those of similar tissues in the animal. Lowering of temperature enhances the amplitude and diminishes the frequency of pulsation in the rhythmic cardiac tissue of the animal. The same is found to be true of the pulsatory activity of

Desmodium gyrans. The effects of various drugs are also very similar. The first result of the application of an anaesthetic like ether is to evoke a transient exaltation, followed by depression and arrest. Poisonous gases also induce a continuous depression of activity. A strong poisonous solution, again, induces a rapid arrest of pulsation.

It has thus been shown that by the waxing and waning of response, the variations in the plant's physiological activity, under changing external conditions, may be gauged. It has been shown also how numerous and varied are the factors that go to make up the complexity of plant-responses. It has been shown that stimulus may be modified in its effect, according as it is direct or indirect, and feeble, moderate, or strong. The modifying influence of the tonic condition of the tissue has also been shown, according as this is normal, sub-tonic, or fatigued. In the numberless permutations and combinations of these varied factors lies the infinite complexity of the responsive phenomena of life.

After a discussion of Professor Bose's paper by Doctors Rusby, Richards, and Pond, the meeting of the Club was adjourned to the second Tuesday in January.

MARSHALL A. HOWE,
Secretary pro tem.

OF INTEREST TO TEACHERS

FOOD FOR THOUGHT

School Science and Mathematics for January gives the following "simple plant experiment" by E. S. Gould, of Galva, Illinois.

"The following device for showing the necessity of CO_2 in photosynthesis may be of use to teachers of botany, especially where apparatus is limited.

"A bell glass with a rubber stopper is placed on an ordinary pump plate. The tube *C* of the plate is closed with a cork. In the cylinder inside is placed NaOH or $Ca(OH)_2$ to absorb the CO_2. Air is forced through tube *A* (tube *B* being open) for a few minutes until the most of the air in the bell glass is devoid of CO_2. What CO_2 is left in the glass will be absorbed by the NaOH in the cylinder. The air is changed every day so that if